

ABSTRACT

Disclosed herein is a method of forming a reliable high performance capacitor using an isotropic etching process to optimize the surface area of the lower electrodes while
5 preventing an electrical bridge from forming between the lower electrodes. This method includes multiple sacrificial oxide layers that are formed over a substrate, an insulating layer with contact plugs, and an etch stopping layer. The sacrificial oxide layers are patterned and additionally isotropically etched to form an expanded capacitor hole. An exposed portion of the etch stopping layer is then etched to form a final capacitor hole exposing an upper portion
10 of the contact plug and a portion of the insulating layer adjacent thereto. The semiconductor substrate having the final capacitor hole is cleaned to remove a native oxide film on the exposed upper portion of the contact plug.